(12) UK Patent Application (19) GB (11) 2 304 835 (13) A

(43) Date of A Publication 26.03.1997

(21) Application No 9618769.5

(22) Date of Filing 09.09.1996

(30) Priority Data
(31) 9518253 (32) 07.09.1995 (33) GB

(51) INT CL[6]
F16H 63/44

(52) UK CL (Edition O)
F2D DBC D101 D130 D132 D179 D200 D203 D204 D211 D212

(56) Documents Cited
GB 1332822 A EP 0390357 A US 4789937 A

(58) Field of Search
UK CL (Edition O) F2D DBC DG
INT CL[6] F16H 63/44

(71) Applicant(s)
Rover Group Limited

(Incorporated in the United Kingdom)

International Headquarters, Warwick Technology Park, WARWICK, CV34 6RG, United Kingdom

(72) Inventor(s)
David Charles Nesbitt
David John Tickle

(74) Agent and/or Address for Service
Robert Michael Farrow
Rover Group Limited, Gaydon Test Centre, Banbury Road, LIGHTHORNE, Warwick, CV35 0RG, United Kingdom

(54) Control of gearshifting in an automatic transmission in series with a manual range gearbox

(57) An automatic transmission 12 is provided along with a range change transmission 14 for providing high and low ranges. A sensor 40 senses the selection of a range change and directs a signal to a transmission controller 24 for the automatic transmission. The controller operates a selector 32 of the automatic transmission 12 to select a gear ratio which is appropriate to the new ratio in the range change transmission 14 and which will maintain the momentum and smooth progress of the vehicle.

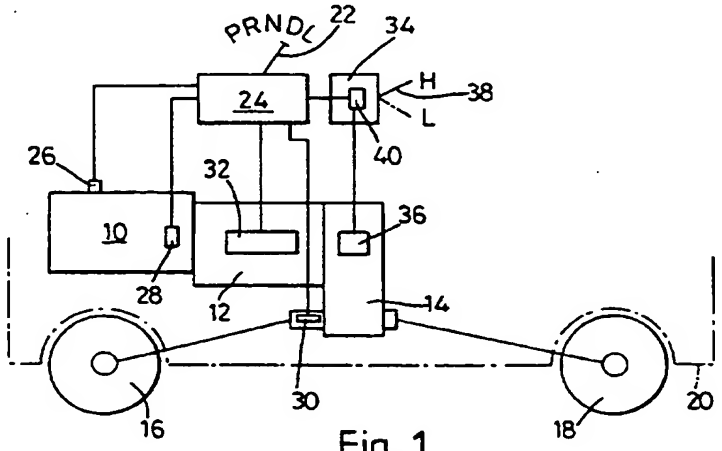

Fig. 1

GB 2 304 835 A

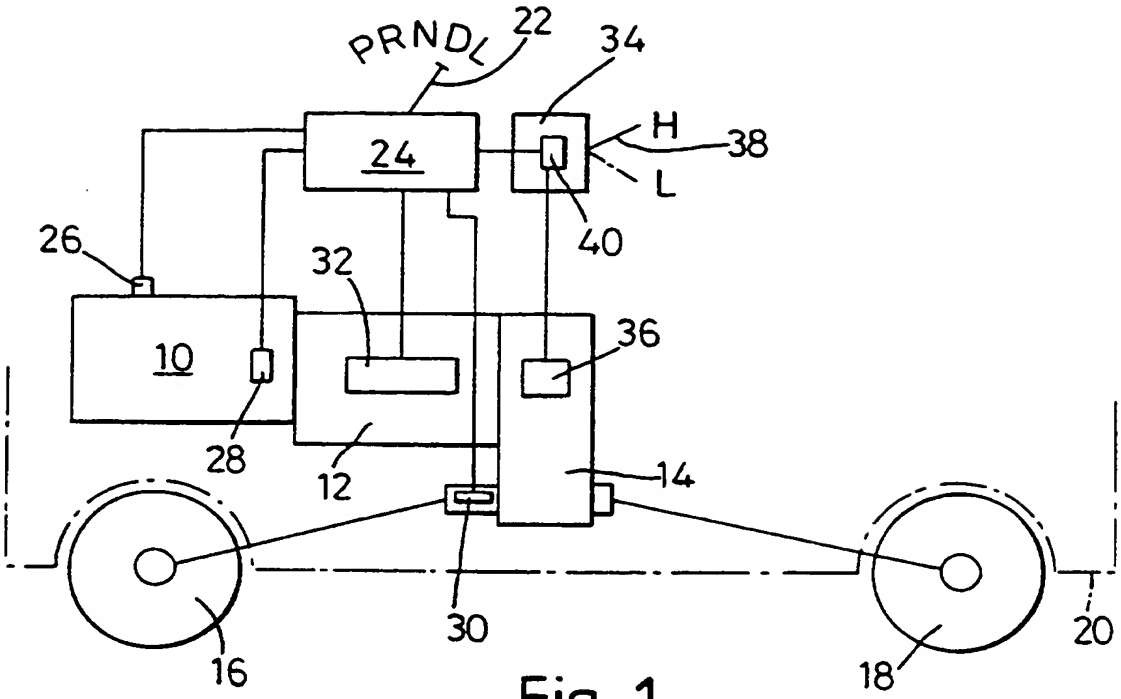
PRNDL
22
34
24
H
38
L
40
26
32
36
10
28
12
14
30
16
18
20

Fig. 1

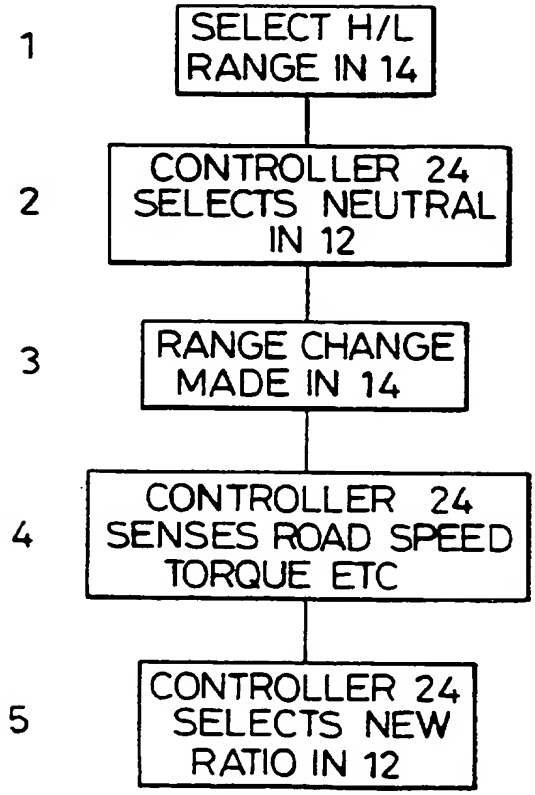
1
SELECT H/L RANGE IN 14
2
CONTROLLER 24 SELECTS NEUTRAL IN 12
3
RANGE CHANGE MADE IN 14
4
CONTROLLER 24 SENSES ROAD SPEED TORQUE ETC
5
CONTROLLER 24 SELECTS NEW RATIO IN 12

Fig. 2

A MOTOR VEHICLE TRANSMISSION

The invention relates to motor vehicle transmissions and is particularly concerned with transmissions of the kind where a main change speed transmission is in series with an auxiliary change speed transmission to provide high and low ranges.

A typical application of such transmissions is on multi-purpose four wheel drive vehicles which are designed for on-road and off-road use. When a range-change is made in the auxiliary change speed transmission to provide a high or low range with the vehicle moving, the driver of the vehicle normally needs to select the correct ratio in the main change speed transmission to maintain the momentum and smooth progress of the vehicle. For example, changing into the high range may require the driver to change down from fourth ratio to second immediately after making the range change.

Where the main change speed transmission is an automatic, the transmission control can detect the new conditions of engine speed and torque following a range change from Low to High and vice versa and change ratios accordingly. However, this reactive type of control causes a further variation or interruption in the power applied to the road wheels immediately following the interruption caused by the range change itself and may cause additional driving difficulties under extreme conditions.

An object of the present invention is to provide an improved transmission of the kind referred to where a change of ratio in the main change speed transmission is made in response to a range change.

According to the invention there is provided a motor vehicle transmission comprising a main change speed transmission, a transmission controller for controlling the ratio of the main transmission in response to vehicle and driver parameters, an auxiliary change speed transmission in series with the main transmission to provide high and low ranges, the main and auxiliary transmissions being driven in use by an engine of the vehicle and driving road wheels of the vehicle, shift means for changing between the low and high ranges in the auxiliary transmission under the direct control of the vehicle driver and a sensor for sensing selection of a range in the auxiliary transmission and providing a range change signal in response thereto, the transmission controller being responsive to the range change signal to select an appropriate ratio in the main transmission following a range change.

Preferably the transmission controller is responsive to engine torque and the ratio selected in the main transmission after a range change is dependent on engine torque immediately before the range change. Conveniently, the transmission controller is responsive to the road speed of the vehicle and the ratio selected in the main

transmission after a range change is dependent on road speed immediately after the range change.

The transmission controller may be responsive to the acceleration of the vehicle and the ratio selected in the main transmission after a range change is dependent on the acceleration during the range change. This is conveniently achieved if the transmission controller is responsive to the road speed of the vehicle and the vehicle acceleration is derived from road speed measured over a short period, e.g. from the beginning to the end of the range change.

Conveniently the transmission controller is responsive to engine speed and the engine speed is controlled by the transmission controller during a range change.

Operation of the auxiliary change speed transmission to effect a range-change initially may be used to cause the transmission controller to select neutral in the main change speed transmission to facilitate the range change to be made. This allows the transmission controller shifts the main transmission from neutral to the new ratio after the range change has been made.

A vehicle transmission in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig 1 is a diagrammatic view of a transmission in accordance with the invention and

Fig 2 is a flow chart setting out the order in which the transmission operates during a range change.

Looking at Fig 1, an engine 10 drives a main change speed transmission 12 which transmits drive to an auxiliary change speed transmission 14. The auxiliary change speed transmission 14 drives front and rear wheels 16, 18 of a vehicle 20.

The main change speed transmission 12 is conveniently a so-called automated manual type, e.g. as described in GB 2 207 715, where a manual type of constant mesh transmission has gear ratios changed by servo actuators and the main drive clutch is controlled automatically. However, other automatic transmissions may be used, including torque converter/epicyclic types and known types of CVTs, e.g. belt or toroidal.

A selector 22 for the main transmission 12 is provided in known manner and connects to a transmission controller 24 which receives various inputs in response to vehicle and driver parameters, for example, from a throttle position sensor 26 to provide an indication of engine torque, from a crank shaft speed sensor 28 to provide an indication of engine speed and from a road speed sensor 30. The selector 22 for the main transmission 12 is movable manually into an

appropriate position represented by the well known gate arrangement PRNDL for an automatic transmission. The controller 24 is arranged to operate ratio selectors indicated generally at 32 in the main transmission 12.

A control module 34 is provided for the auxiliary transmission 14 and operates an actuator 36 of known kind for selecting high and low ranges. A selector switch 38 is provided for manually selecting the high (H) or low (L) range. A sensor 40 in the control module 34 is connected to the controller 24 whereby on selection of the high or low range, the sensor 40 directs a signal to the main transmission controller 24 indicating that the range change is about to be made. The controller 24 causes the appropriate selector 32 to select neutral in the main change speed transmission 12 to facilitate completion of the range change in the auxiliary change speed transmission 14. The controller 24 then determines the optimum ratio in the main change speed transmission 12 for maintaining momentum and smooth progress of the vehicle and causes the appropriate selector 32 to select the most appropriate ratio. Where the PRNDL selector 22 includes an option to select ratios manually, this selection would normally be overridden by the controller 24 but with the selection before the range change taken as one of the parameters.

Fig 2 shows an operating sequence 1-5 from the point that a range change is selected in the auxiliary change speed transmission 14. It will be noted that on selecting

the range change, the main change speed transmission 12 undergoes a shift to select neutral whereupon the range change is then made. On sensing parameters such as engine torque, engine speed and/or road speed, the main change speed transmission 12 is then controlled to select from the neutral position a ratio appropriate to maintain the momentum and smooth progress of the vehicle. Engine torque is preferably measured before the range change so that the ratio selected in the main transmission 12 is matched to the immediately prevailing conditions, e.g. uphill, downhill, soft sand etc. A further indication of prevailing conditions is the vehicle acceleration (which includes deceleration). This may be derived by measuring road speed over a short period of time, e.g. from immediately before to immediately after the range change.

Where appropriate, the range change could be made without shifting the main change speed transmission into neutral, i.e. with a ratio selected. This would be particularly possible where the transmission controller is responsive to engine speed and also controls the engine speed during a gear change.

In place of the switch 38, control module 34 and actuator 36, a direct manual shift of known kind may be provided for the auxiliary transmission 14 to select high and low ranges. The sensor 40 would then directly sense selection of the high or low range, e.g. by microswitches or a Hall effect proximity sensor on the gear shift

mechanism. This would also be an alternative where the switch 38, control module 34 and actuator 36 are used as in Fig. 1 and may have advantages in that any lag or failure in these components would not cause premature or false selection of a gear ratio in the main transmission.

CLAIMS

1. A motor vehicle transmission comprising a main change speed transmission, a transmission controller for controlling the ratio of the main transmission in response to vehicle and driver parameters, an auxiliary change speed transmission in series with the main transmission to provide high and low ranges, the main and auxiliary transmissions being driven in use by an engine of the vehicle and driving road wheels of the vehicle, shift means for changing between the low and high ranges in the auxiliary transmission under the direct control of the vehicle driver and a sensor for sensing selection of a range in the auxiliary transmission and providing a range change signal in response thereto, the transmission controller being responsive to the range change signal to select an appropriate ratio in the main transmission following a range change.

2. A transmission according to Claim 1 in which the transmission controller is responsive to engine torque and the ratio selected in the main transmission after a range change is dependent on engine torque immediately before the range change.

3. A transmission according to any preceding claim in which the transmission controller is responsive to the road speed of the vehicle and the ratio selected in the

main transmission after a range change is dependent on road speed immediately after the range change.

4. A transmission according to any preceding claim in which the transmission controller is responsive to the acceleration of the vehicle and the ratio selected in the main transmission after a range change is dependent on the acceleration during the range change.

5. A transmission according to Claim 4 in which the transmission controller is responsive to the road speed of the vehicle and the vehicle acceleration is derived from road speed measured over a short period.

6. A transmission according to Claim 5 in which the short period is from the beginning to the end of the range change.

7. A vehicle transmission according to any preceding claim in which the transmission controller is responsive to engine speed and the engine speed is controlled by the transmission controller during a range change.

8. A vehicle transmission according to any preceding claim in which the operation of the auxiliary change speed transmission to effect a range-change initially causes the transmission controller to select neutral in

the main change speed transmission to facilitate the range change.

9. A vehicle transmission according to Claim 8 in which the transmission controller shifts the main transmission from neutral to the new ratio after the range change has been made.

10. A vehicle transmission constructed and arranged substantially as described herein with reference to the accompanying drawings.

The Patent Office

11

Application No: GB 9618769.5 **Examiner:** T. S. Sutherland
Claims searched: 1 - 9 **Date of search:** 26 November 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2D (DG, DBC)

Int Cl (Ed.6): F16H 63/44

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 1332822	(KLOCKNER-HUMBOLDT-DEUTZ)	
A	EP 0390357 A	(EATON)	
A	US 4789937	(TOYOTA)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.